



ON HOT-MELT, HEAT-SEAL AND HOT-SET ADHESIVES

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THIS BRIEF NOTE IS PROMPTED by what seems to be a confusion among members of the AIC in the usage of three terms which are established and well-defined in adhesive technology. They are:

1. Hot-melt adhesives, such as wax-resin mixtures,
2. Heat-seal adhesives, such as Beva and PVA,
3. Hot-set (or heat-set) adhesives, such as epoxy resins.

To clear up the confusion I quote from the adhesives glossary published by the American Society for Testing Materials (ASTM, D 907-74) and from the *Adhesives Handbook* by J. Shields (CRC Press, 1970):

Adhesive, hot-melt: "An adhesive that is applied in a molten state and forms a bond on cooling to the solid state" (ASTM). Shields elaborates: "An adhesive material applied at a temperature above its melting point. Usually thermoplastic, wax or 100% solids: adhesives applied between 150 and 200° C."

In the technology of art conservation wax and wax-resin mixtures are adhesives of this type. They are applied in liquid form; they are absorbed by and penetrate through all the porosities of the materials to which they are applied and often stain them. Because of the depth of their penetration, total removal of such adhesives from the impregnated materials becomes impossible.

Adhesive, heat-seal: "The use of heat reactivation to prepare a joint with a thermoplastic material present, as a thin layer, on the adherends, bringing adherend surfaces to their melting point and bonding under pressure" (Shields).

The last word of the above definition—pressure—is of great importance. Indeed, heat-seal adhesives are usually described by the temperature, pressure and the length of time, that is, the dwell time, required to form a bond. See, for example, I. Skeist, *Handbook of Adhesives* (Reinhold: New York, 1962, p. 353, cited by Bernard Rabin when he describes his adhesive in "A Poly (Vinyl Acetate) Heat Seal Adhesive for Lining," *Conservation and Restoration of Pictorial Art*, N. Bromelle and P. Smith, eds. (Butterworth: London, 1976): "Skeist reports a minimum heat-seal temperature of 60°C for AYAA, 1.5 sec. dwell-time at 60 lb. per sq. inch." The high viscosity of the heat-seal pressure-sensitive adhesive prevents it from penetrating into the voids (porosities) of the materials to be bonded even under the pressure required to form the bond. The result is a bond that forms only on those surfaces which are in direct contact with each other. This explains why *heat-seal adhesives do not stain* and, if prepared from stable *thermoplastic* materials, can be easily and completely removed from almost every material used as an art support, including absorbent and/or thin substances such as old silk or tissue paper.

The differences between the above two types of adhesives are considerable. Yet in the paper "Treatment of a Flood-Damaged Oil Painting on a Solid Support" by David C. Goist, the author writes: "When the wheat paste and paper were dry, each sheet was coated evenly with the "Hot-Melt" adhesive devised by Bernard Rabin" (Journal of the AIC, XVI, 2, p. 24), although in his reference he quotes the title correctly: "Rabin, B., "A Poly (Vinyl Acetate) Heat Seal Adhesive for Lining," cited above.

Both hot-melt and heat-seal adhesives may be called thermoplastic because they do not change chemically when heated and because their bonds can always be reversed by heat. This is not the case with the third type, hot-set adhesives.

Adhesive, hot-setting: An adhesive with a setting temperature of 100°C (212°F) or more (ASTM and Shields).

For the purposes of conservation, the term “hot-setting” might also be used for adhesives which harden, or set, at temperatures below 100°C, because many art objects cannot take such a high temperature. However, the term “set” under elevated temperature needs further explanation, Shields provides such an explanation: “Thermoset—a material which does not soften on heating, as a result of being formed from an irreversible chemical reaction initiated by catalysts: heat, light, radiation, etc.”

Thermosetting in the polymer and adhesives technology denotes crosslinking. Many thermosetting materials are used in industry as adhesives. The fact that they cross-link increases their resistance to plastic deformations and creates bonds which are more resistant to solvents, creep, and elevated temperatures. However, such adhesives are not acceptable for lining or mounting fragile, absorbent art objects, such as paintings, paper, or textiles. Cross-linking makes it impossible to remove such adhesives without causing damage to the original materials of the art objects.

Reference is made to the paper “Heat-Set Tissue” by Margaret Hey and Peter Waters, presented to the Annual AIC meeting in Boston in June 1977 and given out to all those present in the form of a preprint of the contribution. On page 10, lines 20 through 22 and the Table which follows, the authors state that results of their tests showed *Plextol* B-500 and Rohm & Haas B-72 to be free of cross-linking. If this is so, then the term heat-set, which means cross-linking under heat, does not apply here. In fact, it is misleading, as is the description supplied by Promatco of its solublenylon tissue, which also claims that it is permanently reversible. It should, therefore, be called Heat-Seal Tissue and not Heat-Set Tissue. Should Mr. Waters continue to call his heat-seal tissue heat-set tissue, he will create the misconception that the adhesive cannot be removed once it is applied or that heat-setting, i.e. cross-linking at elevated temperatures, is an acceptable quality in paper adhesives. As mentioned above, the wrong term is also used by Promatco and, as a result, was repeated by Miss K. O. Scott in her paper presented to the Annual Meeting of the AIC in Fort Worth, Texas, in June 1978.

Such inaccuracy tends to spread, and soon conservators in the United States may no longer be able to discern between desirable and damaging qualities in the materials they use.